Review of Recent Developments in Solar Heat for Industrial Processes

Klaus Hennecke

Content and Acknowledgements

Content:

- Motivation
- Market potential
- Challenges
- Recent and current projects
- SHC/SolarPACES Task 49/IV
- Concluding remarks

Thanks for contributions from:

- Dirk Krüger, Nils Reiners
- Christoph Brunner, AEE INTEC
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- Francesco Orioli, SOLTIGUA
- Klemens Jakob, SMIRRO
- Christian Zahler, Industrial Solar
- Ken May, Abengoa Solar Inc.

Renewable Energy Technologies for Power Generation

Geothermal

Hydro

Solarthermal

Biomass

Tidal

Wave

Photovoltaic

Wind

Renewable Energy Technologies for Process Heat

Geothermal

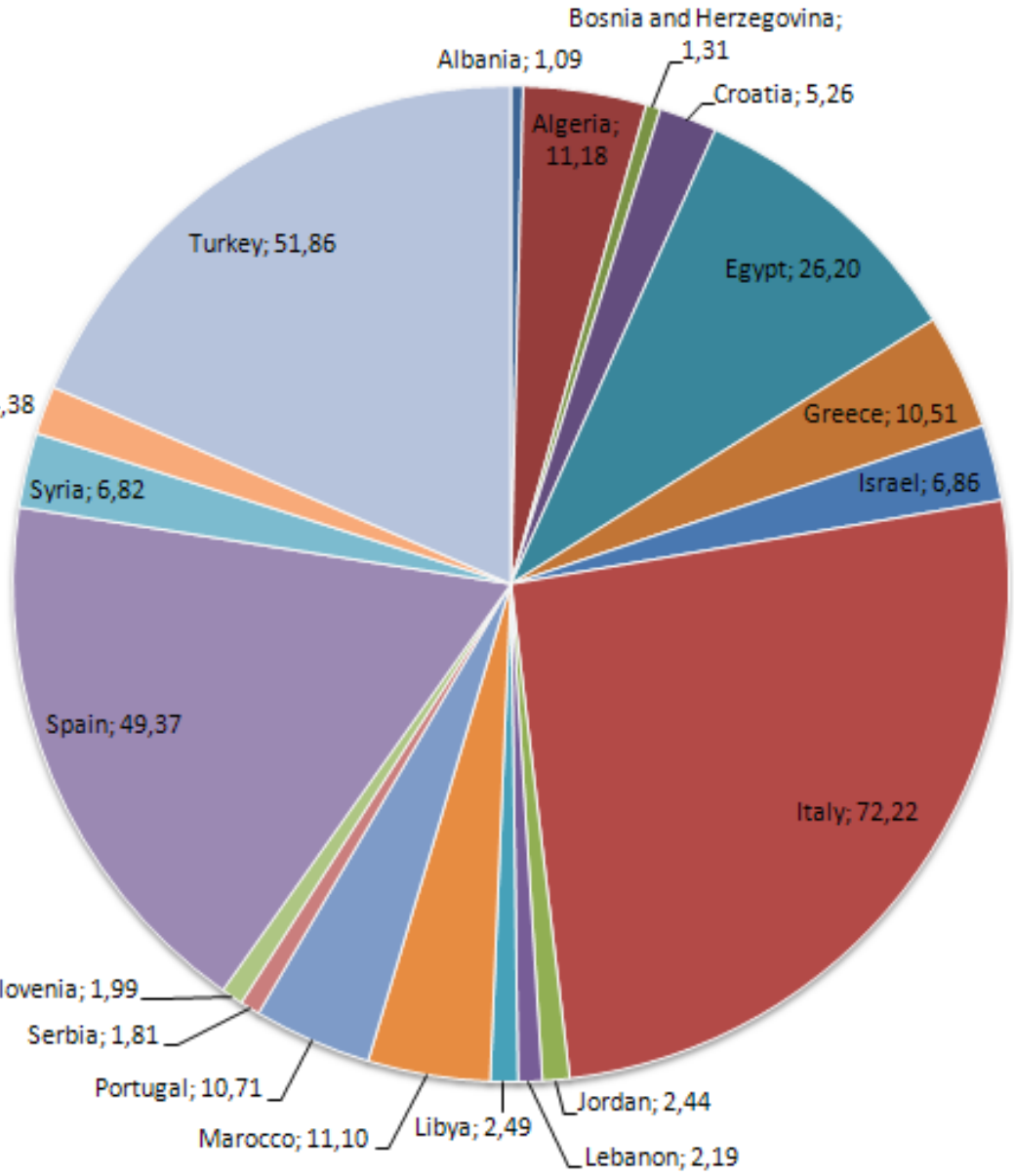
Concentrating Solar

Biomass

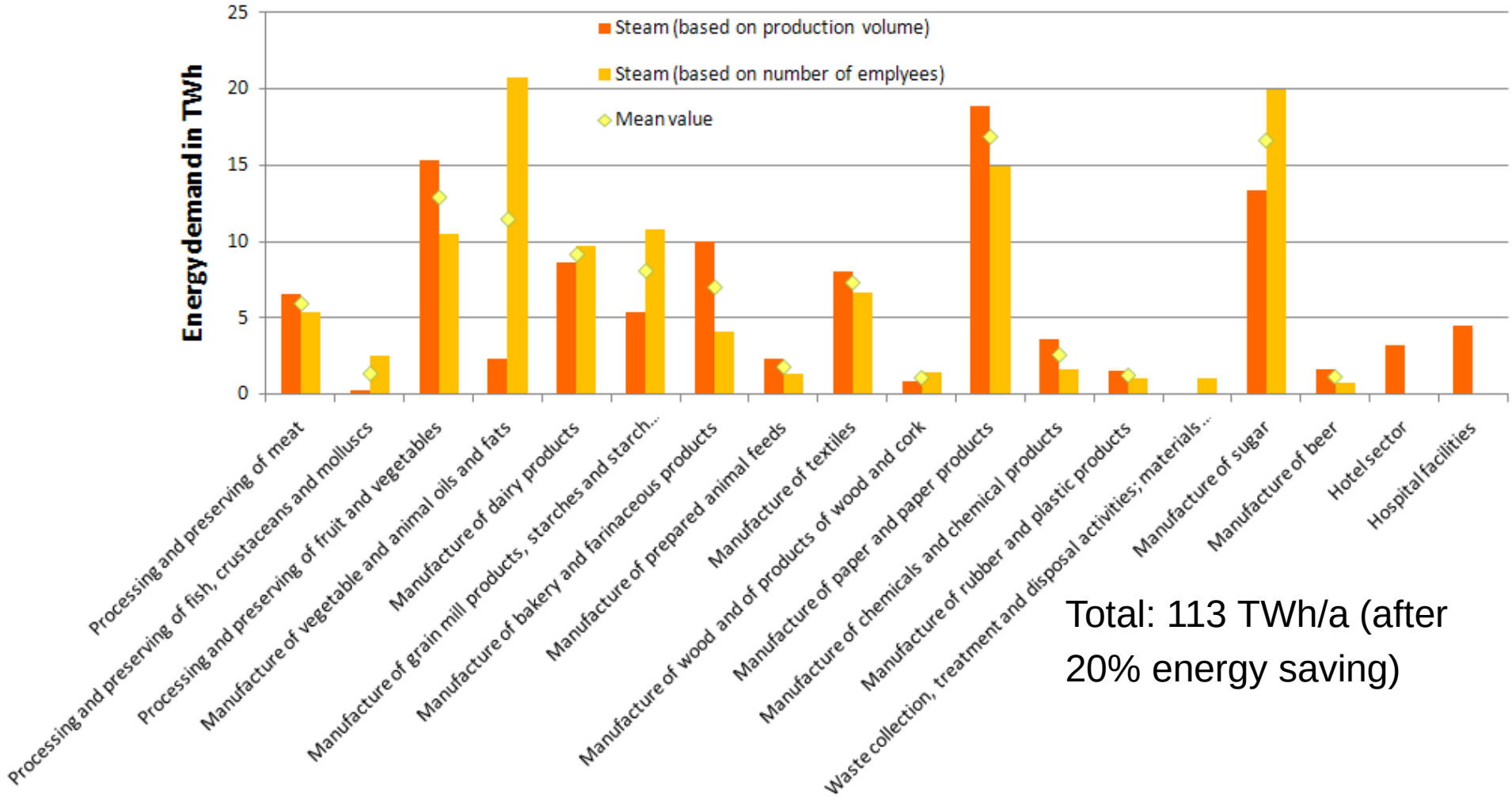
Non-concentrating Solar

Process Heat Demand in Mediterranean Countries

Total Process Heat Demand
280 TWh/a
after 20 % energy savings



Process Steam Demand by Industry Sectors

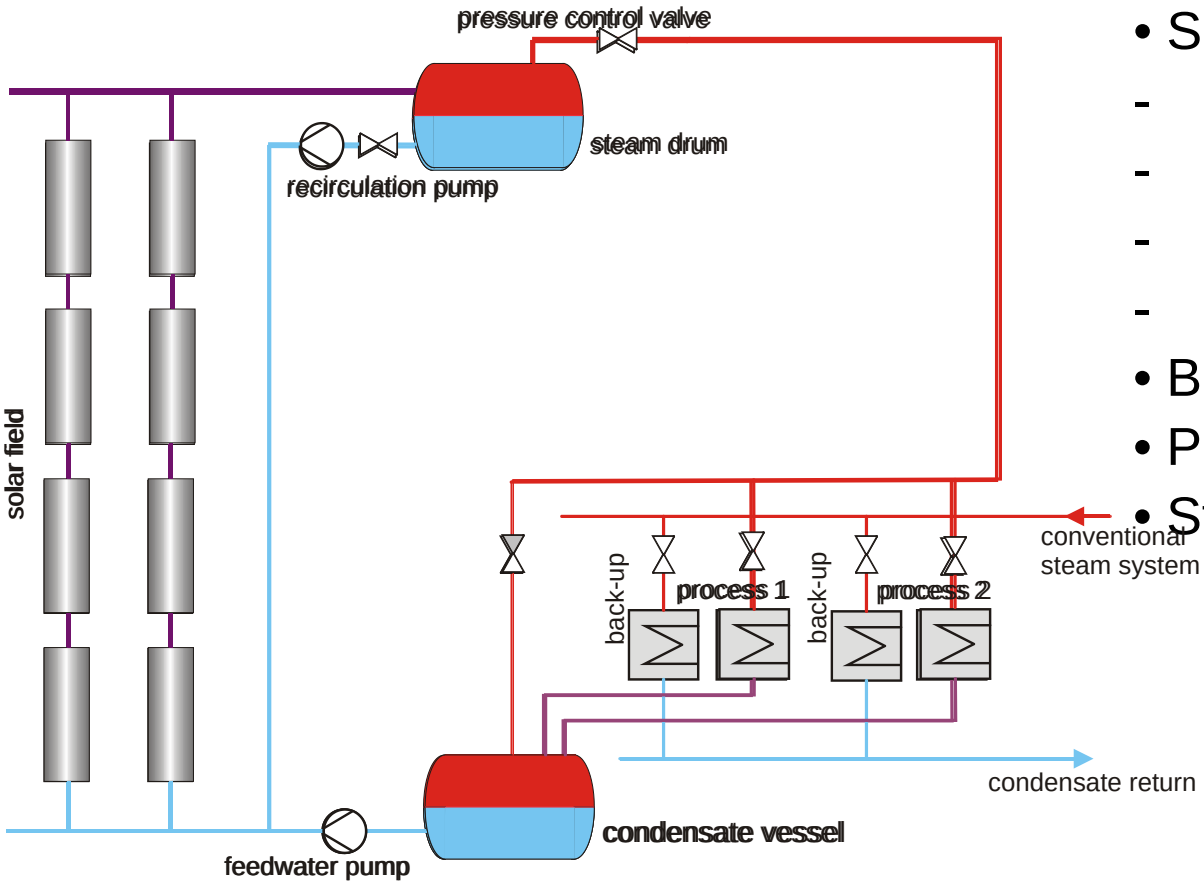


Total: 113 TWh/a (after 20% energy saving)

Challenges in Solar Process Heat

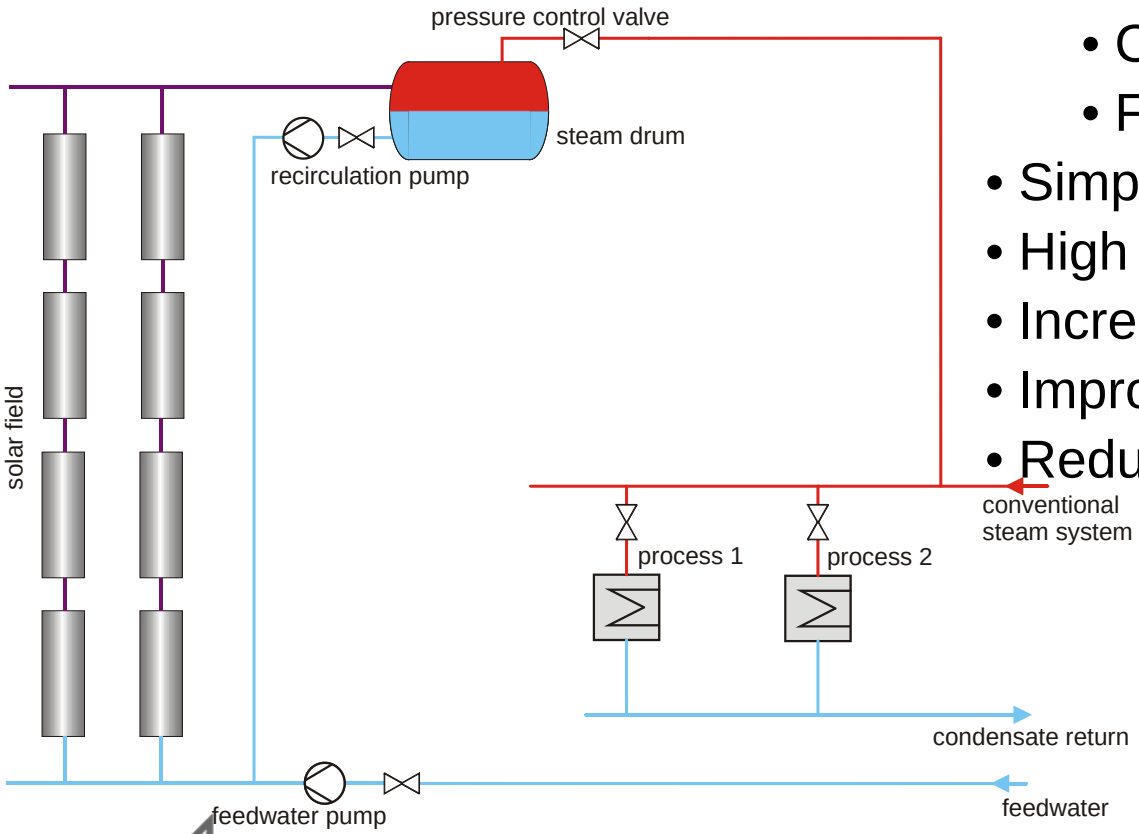
- Heat cannot be transported easily over long distances
  - Meteorological conditions at the site
  - Availability of suitable areas for collectors (ground, roof, facades)
- Solar field size (= investment cost) proportional to heat demand
  - Rational use of energy minimizes heat demand
  - Process optimization more cost effective than “free” solar energy
- Collector efficiency temperature dependent
  - Selection of suitable collector technology
  - Integration of solar heat at appropriate temperature
- Annual, daily and stochastic variations of radiation
  - Load management, heat storage or conventional back-up
  - Similar load and radiation profiles may increase solar share
- O&M effort for additional technology
  - Priority for O&M personnel: Efficient production
  - Fully automated solar operation

Direct steam supply to selected processes



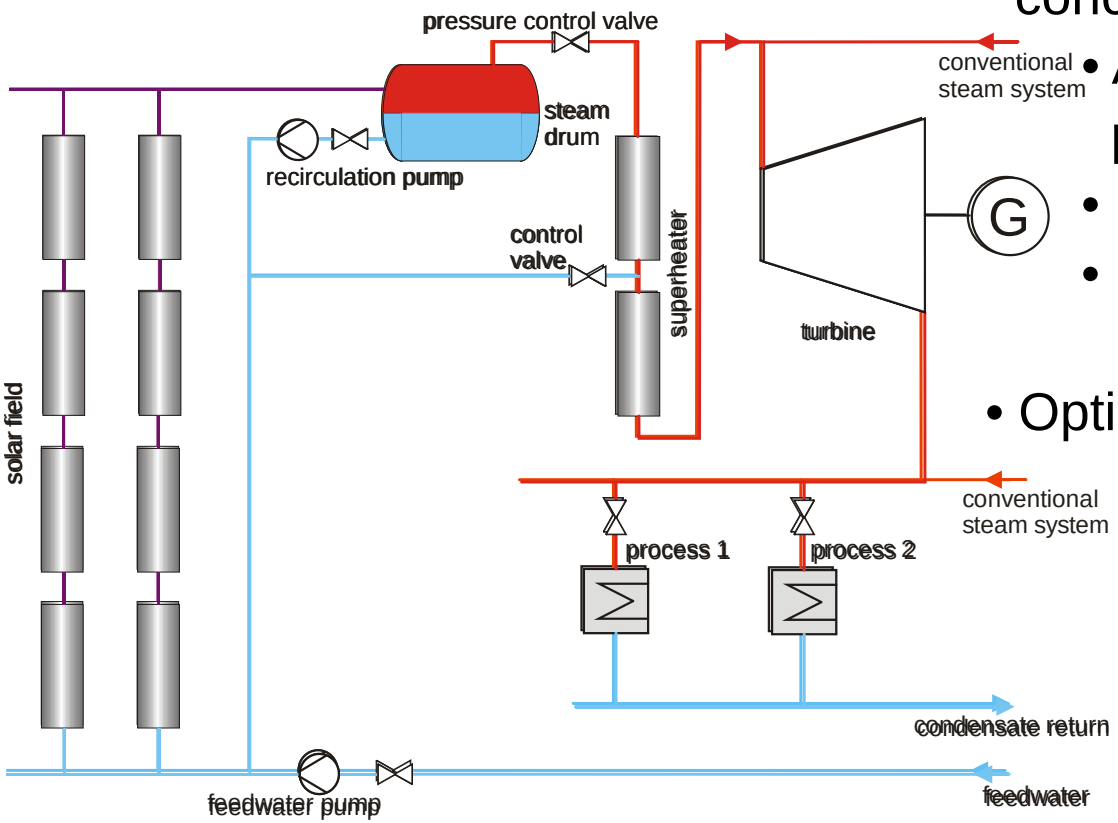
- Optimized temperature level
- Separate solar heat system
  - Steam distribution
  - Condensate return
  - Feedwater treatment
  - Safety features
- Back-up Control
- Process demand profiles
- Storage requirements

Indirect steam supply via existing steam distribution



- Utilisation of existing infrastructure
  - Steam Distribution
  - Condensate return
  - Feedwater treatment
- Simple back-up control
- High security of supply
- Increase of potential solar share
- Improved solar capacity factor
- Reduced storage requirement

High pressure steam for co-generatiom



- Exploitation of exergy potential of concentrating collectors
- Added value from electricity production
- Increased investment
- Increased complexity

- Option: hybrid co-generation

Recent and current Projects

EU InSun Project (started early 2012):
Solar Process Heat demonstration plants in 3 different industries

Co-ordinated by zafh.net
Centre of Applied Research Sustainable Energy Technology at University of Applied Sciences Stuttgart

Dr. Dirk Pietruschka

InSun
Meat Factory Berger, Austria/Sieghartskirchen

Key data

- 1077 m² Flat Plate Collectors (glutamugl HT)
- 60 m³ hot water storage tank

Hot water preheating for dehumidification of maturation chambers

- 5 – 10 m³/h hot water demand
- Usage of waste heat until 40° C
- Solar heating up to 70°

Preheating feed water for steam production (ham cooking)

- 3 m³/h hot water demand
- Usage of waste heat until 30° C
- Solar heating up to 95°

Mein BERGER Schinken

SOLID solarinstallation+design

DLR

InSun
Brick drying at Laterizzi Gambettola, Italy

soltigua concentrating solutions

Key data

- 2.640 m² Linear Fresnel Collector (Soltigua FTM36)
  - 1.056 m² Thermo oil / HX steam generator
  - 1.584 m² Direct steam generation
- Peak solar field capacity: 1,2 MW

Application:

- Brick drying at 200 to 260° C
- Steam production at 180° C (12 bar) for air preheating and to supply the steam driven radiant heat exchangers in the new innovative brick dryers.
- Required total heating power: 2.2 MW
- Heating energy demand: 12 GWh/a

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InSun
Brick drying at Laterizzi Gambettola, Italy

soltigua concentrating solutions

Ground Preparation and Collector Field Installation, Status End of August 2012






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InSun
Milk powder production at Lácteas Cobreros (LACO) Castrogonzalo-Zamora, Spain

Key data

- 2.040 m² Parabolic Trough Collector (Smirro)
- Solar field design capacity at 200° C: 1 MW
- HTF: Thermal oil

Application:

- Milk Powder drying at 185° C (120-150 d/yr)
- Production capacity: 2000l milk per day
- Pasteurizing processes and water heating
- Steam production at 195° C
- Required total heating power: 1,5 MW (24 h/d)
- Heating energy demand: 35 MWh/d

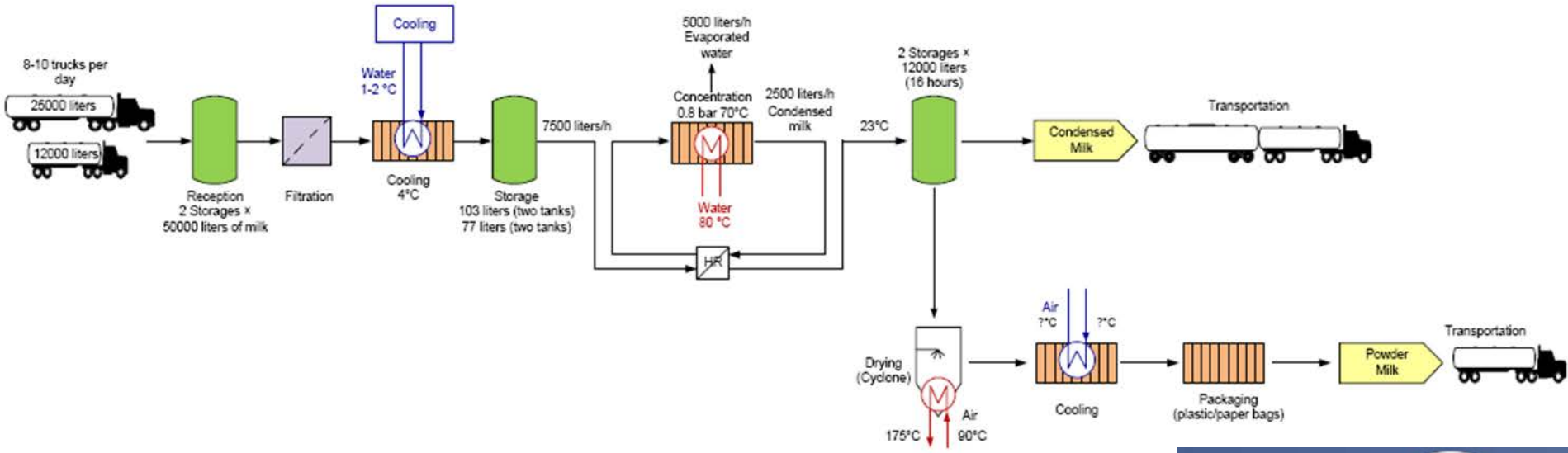
Lácteas COBREROS

SMIRRO™

DLR

InSun
Milk powder production at Lácteas Cobreros (LACO) Castrogonzalo-Zamora, Spain

Condensed and Powder Milk Production



Lácteas COBREROS

sMIRRO™

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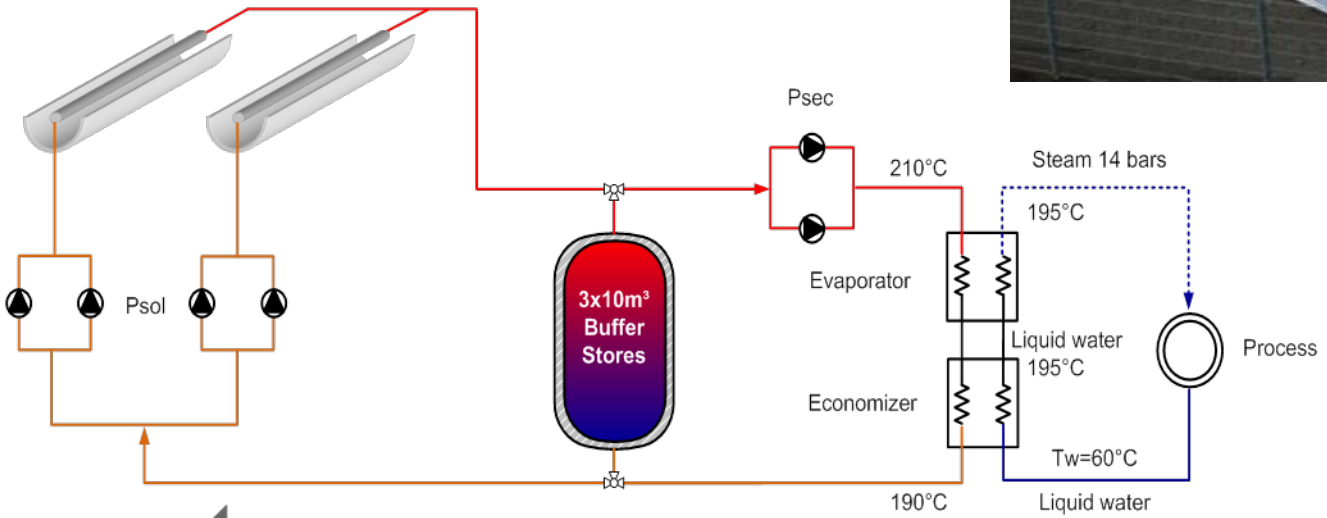
InSun
Milk powder production at Lácteas Cobreros (LACO) Castrogonzalo-Zamora, Spain

Smirro 40 kW reference plant in Germany

LACO plant schematic



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Recent and current Projects

NEP Solar Emmi solar process heat plant on the Tête de Moines cheese factory in Saignelégier, Switzerland.

17x NEP Solar PolyTrough 1800 collectors Commissioning Sept. 2012

Hot water/antifreeze circuit , 130° C

627m², 400kW nominal heat capacity

Recent and current Projects

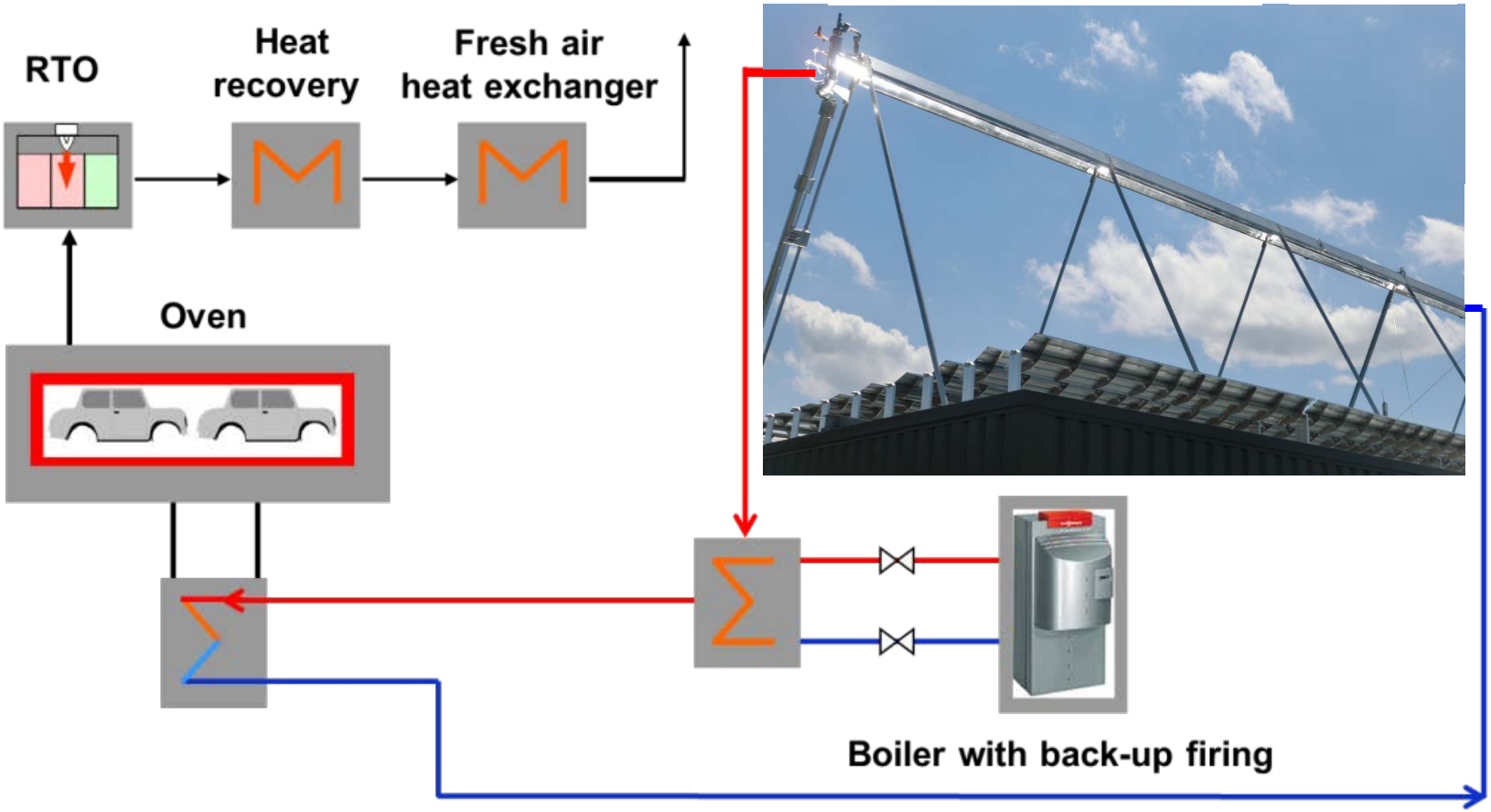
NEP Solar: Ewz / LESA solar process steam plant in Bever, Engadin, Switzerland, Commissioned Nov. 2011

Quick Facts

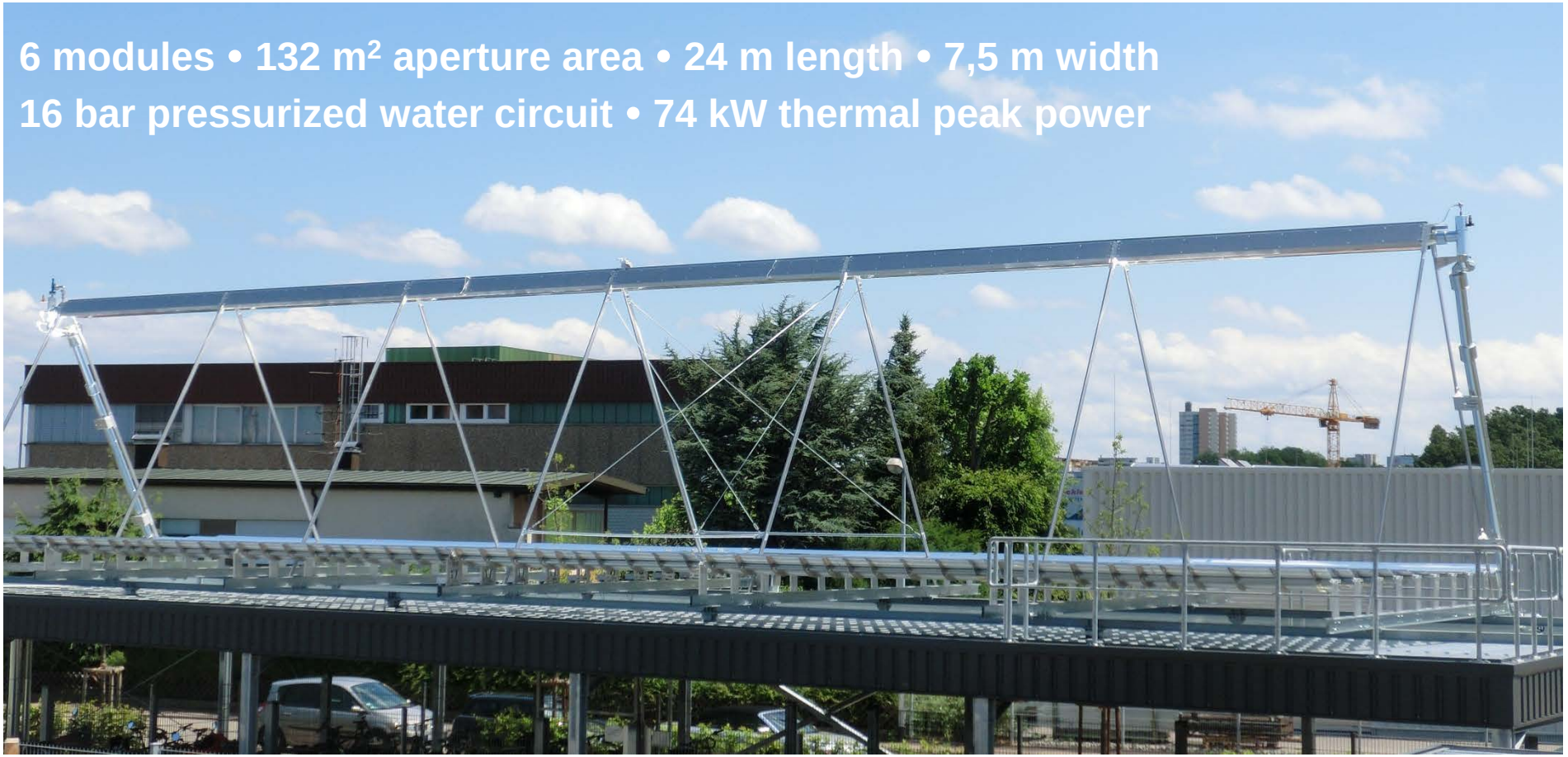
- 4x NEP Solar PolyTrough1200
- 116m², 70kW
- thermal oil circuit, 180-200° C supply temperature
- 4-6bar saturated steam production in tube-and-shell steam generator
- Injection of steam in existing steam network of milk processing plant

Recent and current Projects

Industrial Solar: Dürr Paint Oven
Bietigheim-Bissingen, Germany



Industrial Solar Installation at Dürr



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ABENGOA SOLAR INC.

- Process heat
- Frito Lay (PepsiCo)
- Modesto, California, USA
- Operational 2008
- 5.068 m²
- 250° C, 41bar
- Indirect steam generation

- Back-up by natural gas fired steam generators

- Heating of oil used for cooking corn and potatoe chips

- Largest industrial solar thermal system in US

ABENGOA SOLAR INC.

- Process heat
- Steinway and Sons
- Long Island City, New York, USA
- Operational 2010
- 501 m²

- Back-up by natural gas

- Heating and cooling, process steam

- Humidity control of piano „action“ department

IEA SHC Task 49/IV: Solar process heat for production and advanced applications

Task lead: AEE INTEC (Christoph Brunner)
Joint Task with SolarPaces (Klaus Hennecke – DLR)

Start 2012, Duration 4 years

- Subtask A: **Process heat collector**
  (Dr. Elimar Frank - SPF)
- Subtask B: **Process integration and Process Intensification combined with solar process heat**
  (Bettina Muster – AEE INTEC)
- Subtask C: **Design Guidelines, Case Studies and Dissemination**
  (Dr. Werner Platzer – Fraunhofer ISE)

Concluding Remarks

- Industrial heat applications are a significant potential market for concentrating solar technologies
- Suitable collector technologies are offered by a number of suppliers
- First demonstration projects have been realized, or are under development
- Challenges remain:
  - System Integration / Optimization
  - Plant engineering
  - Collector improvements
  - Competitiveness with other heat sources / Incentive schemes

- The joint SHC/SolarPACES Task 49/IV provides a good forum for cooperation
  - Task Website: www.iea-shc.org/task49/
  - Contact: klaus.hennecke@dlr.de

  - Next Task meeting: SPF, Rapperswil, Switzerland, February 4-6, 2013
  - SHC Conference 2013, Freiburg, Germany, September 23-25, 2013

Hope to see you there!